all involved, especially the public, who benefit from the work of both disciplines.

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The Natural Alliance of Psychology and Nursing: Substance as Well as Practice

Sandra K. Mitchell,
Kathryn E. Barnard, Cathryn L. Booth,
Diane L. Magyary, and Susan J. Spieker
University of Washington
School of Nursing

DeLeon, Kjervik, Kraut, and VandenBos (November 1985) described the "natural alliance" of psychology and nursing, centering around "defining the appropriate scope of practice" in each discipline. Although their discussion did an admirable job of illuminating the historical parallels between clinical psychologists and clinical nurse specialists (such as nurse practitioners), it leaves the impression that these legal and policy issues are the only links between the two disciplines.

In our experience, there is also a "natural alliance" between psychology and nursing based on subject matter. Nursing is concerned with human responses, some of which are psychological, to states of illness and wellness. Research in nursing science is concerned with describing and predicting those human responses and with testing interventions that alter them. It goes without saying that psychology is involved in similar ways with human responses of many kinds, including those related to health.

This alliance between nursing and psychology is probably most obvious in the subareas of psychosocial nursing and health psychology. Research and practice in psychosocial nursing center on the care of clients with mental and emotional illnesses. Consequently, both scholars and clinicians working in this subarea have much in common with professionals in other disciplines who share the same clientele and concerns. Health psychology, on the other hand, serves clients whose illnesses include somatic aspects. The research and practice priorities of health psychologists, then, often overlap with those of other health professionals, including nurses.

What may be less obvious is that other specialty areas in nursing and psychology also have considerable overlap. As one example, consider parent and child nursing, a specialty area including the traditional concerns of maternity and pediatric care. At the University of Washington in Seattle, the Parent and Child Nursing Department includes, among its 41 faculty members, 9 with doctoral degrees in psychology or educational psychology, 2 with interdisciplinary doctoral degrees in which psychology played a key part, and 2 with degrees in nursing science whose dissertations were psychological in nature. These 13 faculty members range in rank from research associate to full professor; some have regular academic appointments, and others serve on the research faculty; some, but not all, are registered nurses. Together, they bring to their work graduate training in clinical, counseling, developmental, social, experimental, cognitive, and physiological psychology, as well as expertise in research methods, design, and measurement. All are involved to some degree in the research activities of the Nursing School, recently reported to be number one in the country (Chamings, 1984). These research projects range widely in content and scope and include such topics as home intervention in high-risk families with newborns, parent education to reduce disruptive behavior in preschoolers, provision of effective education for children with chronic illnesses and their parents, and improvement in the care of infants in neonatal intensive care units. Many of these faculty are associated with the University's Child Development and Mental Retardation Center, and six of them are also members of the MacArthur Foundation Research Network on the Transition from Infancy to Early Childhood. Both of these affiliations represent substantial investments in interdisciplinary work that includes not only nursing and psychology but also pediatrics, social work, psychiatry, nutrition, and other allied disciplines.

Although our department and school may be somewhat unique in the extent of collaboration between nursing and psychology, we believe that the "natural alliance" is a strong one, and we expect to be joined in these collaborative ventures by other psychologists and nurses around the country.

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Further Implications of Anomalous Observations for Scientific Psychology

Oliver W. Hill
Virginia State University

Recently, Child (November 1985) pointed out that many anomalous observations within psychological (specifically, parapsychological) research are barred from consideration by the mainstream of psychology through both neglect and misrepresentations due to the philosophical prejudice of reviewers. Specifically, he described research conducted at the Maimonides Medical Center on possible telepathic information transfer during dreaming. This study appears to have been well designed, with results that are extremely compelling. Even for those who reject the explanation of extrasensory perception (ESP) out of hand, the results represent intriguing data that need to be accounted for. As Child pointed out, serious consideration of apparent anomalies seems an essential part of the procedure of science, and it is important that accurate information about such anomalous findings be disseminated within the fold of psychologists. Often, however, scientific psychologists have difficulty keeping on top of the literature within even a narrow domain of interest and never venture beyond the boundaries of their immediate research. However, certain potentially revolutionary findings that have implications for the most fundamental tenets of our world view, such as the results reported on by Child, are relevant to and should be considered by all scientists. This is particularly true in the case of some recent anomalous experimental findings in the area of quantum physics (Aspect, Dalibard, & Roger, 1982) that have great implications for all of the natural sciences, including psychology.

The dominant philosophical views within psychology and the other natural sciences can be characterized as realism and physicalistic monism. Realism is the view that external reality exists and has

definite properties independent of any act of observation. Physicalistic monism is the view that the processes commonly referred to as "mind" or "consciousness" are totally reducible to underlying physical processes.

A third fundamental assumption that has exerted a strong influence on the world view of science could be termed *the locality assumption* (or Einstein separability), which holds that events can have only local influence, with the maximum boundary constrained by the speed of light. (It is this assumption specifically that makes many of the findings of parapsychological research "anomalous.") These three assumptions about reality have formed the basis for the current scientific paradigm. The results of the Aspect experiment (as well as the Maimonides research) seem to call for a reevaluation of some of these above-mentioned assumptions.

Local realistic theories of physical reality place a limit on the extent to which distant events can be correlated, whereas quantum mechanics allows this limit to be exceeded. Those physicists who felt uncomfortable with the paradoxes that abound in the predictions of quantum mechanics, such as the seeming connection of particles at a distance, felt that these relationships would be explained by some as-yet-undiscovered supplementary parameters or "hidden variables" that represent the actual underlying reality—the fundamental clockwork—below the unreal world of the quantum.

The Aspect et al. (1982) experiment was designed to test directly the predictions of "hidden variable" theories versus the predictions of quantum mechanics regarding the behavior of photons scattered in opposite directions from a source. Streams of photon pairs scattered in opposite directions from the same source were passed through polarizers whose settings were varied randomly and observed by two detectors that measured the polarization of the split pairs. According to quantum theory, this property of polarization does not exist until it is measured. Classical realistic theories such as the hidden variable explanation hold that each photon has a "real" polarization from the moment it is created. Because the photon pairs are emitted simultaneously, their polarizations are originally correlated, but quantum theory and hidden variable theories make different predictions about the nature of the final correlations after the photons pass through the polarizers and the detectors. In particular, hidden variable (local realistic) theories predict that the final correlations between the photon pairs will obey a relation called the Bell inequality (for a detailed discussion, see d'Espagnat, 1979), whereas quantum theory predicts a violation of the inequality. In essence, quantum theory predicts that measuring the polarization of one photon in a pair "causes" (this term is used loosely) a change in the polarization of the second to bring it into correspondence, even though the two are far enough apart that a causal signal would have to propagate faster than the speed of light in order to connect them.

Since 1972, five of seven experimental tests of the Bell inequality have supported the predictions of quantum theory. However, none of these earlier experiments was a rigorous test of Einstein separability (i.e., that no signal can propagate faster than the speed of light), because the settings of the polarizing and detecting instruments were determined well in advance, and a possible argument could be made that the setting of one of the instruments might conceivably affect events observed at the other (this influence would not have had to propagate faster than light), or the settings of the instruments could have modified hidden parameters at the source of the photon pairs.

The major improvement in the Aspect et al. experiment involved adding rapid switching devices that changed the settings of the instruments while the photons were in flight. Each polarizer was replaced by a setup involving a switching device followed by two polarizers with different orientations. The two switches were driven at different frequencies, making them function in an uncorrelated way. Switching occurred about each 10 nanoseconds, compared to the photon transit time of about 20 nanoseconds. It was thus impossible for any information about the experimental setup to travel from one part of the apparatus to the other and affect the outcome of any measurement unless such an influence was exceeding the speed of light.

The results of the Aspect et al. experiment support the predictions of quantum mechanics. When the polarization of a photon was changed, the second photon was changed in the same manner. In other words, the photons started out with the same polarity and were found to still have the same polarity after each passed through an independent device that shifted its polarity to one of two possible states at random. These results violate the Bell inequality (which limits the correlations of the photons based on the considerations of set theory) by five standard deviations. Thus, this more rigorous procedure violated the inequality to a greater extent than any of the previous tests. Local realistic (hidden variable) theories therefore appear to be untenable, and at least one of the premises underlying those theories of reality (i.e., realism or Einstein separability) must be in error.

Now invoking another basic assumption of science—that it is legitimate to draw general conclusions from consistent observations or experiments—we must consider the macroscopic implications if the picture of reality that quantum theory gives us is valid. This has implications for measurement and logic, two of the fundamental epistemological tools of science, in terms of their ability to answer ultimate questions about our existence.

With the emphasis on measurement, the world is reduced to quantities and the relationships between them. There is a fundamental belief that the quantitative description of things is paramount and even complete in itself. It is as if we have given measurement ontological significance and confused quantification with explanation. Despite their utility, and even necessity in most scientific endeavors, operational definitions lack any kind of ultimate meaning and therefore are not satisfactory for achieving a final understanding of the world. Because they are so much a part of our ordering schema of reality, we forget the arbitrariness of our units of division and measurement, including even the most basic units of extention and duration. There is a culture whose basic temporal unit is the time it takes a pot of rice to boil. Our units of nanoseconds are certainly more sophisticated and accurate but no less arbitrary. These divisions (such as seconds and centimeters) are not a part of objective reality but are part of the cognitive framework that we have created in order to organize that reality.

Quantum paradoxes point to the limitations of logic and measurement for even the understanding of basic levels of physical reality. Logical absolutes (e.g., something cannot be both A and not-A simultaneously) break down at the quantum level. What is termed the "problem of measurement," exemplified by the Heisenberg uncertainty principle, tends to puncture our image as uninvolved observers as we measure so-called "objective" reality.

Of course the ultimate limitations of logic are in the areas of self-reference and completeness—a logical system is not capable of explaining itself, and for any sufficiently powerful logical system, there will be truths not expressible as theorems of that system. There is thus a good possibility that we may have to transcend logic as the sole criterion if we are to achieve

levels of ultimate ontological understanding.

We must recognize that measurement implies consciousness, and not rule out the possibility of consciousness playing a primary role in even our understanding of physical reality. The relationship of consciousness to measurement is involved in our basic conceptualization of "number" and "quantity." Number not only implies comparison (which ultimately involves subjective criterion) but also seems to be intimately connected to such troublesome (anomalous?) concepts as infinity and the cardinality of the continuum.

One very basic conceptual pitfall can be illustrated by the way in which we conceptualize infinity. Infinity is usually thought of in terms of vastness or a very large number, when of course the concept has nothing to do with "largeness" or even "number." It is not a point on the number line, but a different order of things entirely (I am as "close" to infinity at one as I am at one million). Yet infinity seems to underly the number line and to be implied by the existence of quantity. A better conceptualization of infinity would be as undivided wholeness.

This concept of undivided wholeness may lead to the key in solving many of the anomalies implied by quantum theory or posed by the results of parapsychological research. To explain the type of phenomena we have been considering in the experiments mentioned above, several theorists have proposed that an object (e.g., a photon or a dreaming subject) is an abstraction from some underlying wholeness, thus reversing the usual conceptualization of the relationship between part and whole. This underlying wholeness would represent a different order of reality that is unmanifest in nature. The underlying reality is termed the *implicate* (or *enfolded*) *order* by Bohm (1973). Space, time, and matter represent the *explicate* (or *unfolded*) order. Bohm stated:

> One is led to a new notion of unbroken wholeness which denies the classical idea of analyzability of the world into separately and independently existing parts. . . . We have reversed the usual classical notion that the independent 'elementary' parts of the world are the fundamental reality, and that the various systems are merely particular contingent forms and arrangements of these parts. Rather, we say that inseparable quantum interconnectedness of the whole universe is the fundamental reality, and that relatively independently behaving parts are merely particular and contingent forms within this whole. (Bohm & Hiley, 1975, pp. 96, 102)

Thus, in the case of space-like separated photons (or dreaming subjects and isolated "senders"), the connectivity might not be based on some transference of energy, but on the underlying whole from which both are abstracted. It remains a paradox only as long as we are bound to our classical realistic notions of space, time, and discreteness.

What meaning does all this have for psychology as a science? The issue here concerns metaphor and vision, assumptions and values. Although there have been several proposals by brain researchers that single quantum exchanges may be significantly involved at the synaptic junction (see, e.g., Eccles, 1953; Walker, 1970), most psychologists and philosophers of psychology have tended to either ignore completely or downplay the relevance of quantum theory for psychology. This is especially true in the case of anomalous implications of quantum theory, such as the effects of the observer on the observation (implied by the Heisenberg uncertainty principle), because such effects were thought to be negligible on macrostructures. For example, Feigl (1975) stated:

> The influence of observation on observed objects maintained by a majority of present-day physicists is in any case negligible in regard to macro-objects. It does not hurt the moon to look at it, even if electrons get a 'kick' out of being looked at. (p. 21)

But this type of argument is based on the naive classical assumption that quantum uncertainty is based on some disturbance of a system during the measurement process. This, however, is not the case. The uncertainty exists in the nature of reality itself. According to the fundamental equation of quantum mechanics, there is no such thing as an electron that possesses both a precise momentum and a precise position. Bohr (1958), one of the founders of quantum mechanics, stated: "In quantum mechanics, we are not dealing with an arbitrary renunciation of more detailed analysis of atomic phenomena, but with a recognition that such an analysis is *in principle* (italics his) excluded" (p. 62). The implications of the experiments based on Bell's inequality have given indications that many of the paradoxes of quantum mechanics extend into the world of macroscopic events as well (see Clauser, 1976; Freedman & Clauser, 1972; Fry & Thompson, 1976; Lamehi-Rachti & Mittig, 1976). In the words of Stapp (1971),

> The important thing about Bell's theorem is that it puts the dilemma posed by quantum phenomena clearly into the realm of macroscopic events. . . . (It) shows that our ordinary ideas about the world are somehow profoundly deficient even on the macroscopic level. (p. 1303)

The Aspect et al. (1982) experiment in particular should serve as a caveat to shake us out of our complacency regarding some of our most cherished and implicit assumptions about the nature of reality. Concepts that have been fundamental to the description of the physical world for centuries, such as discreteness, causality, time, space, and number, have come into question during the last 70 or 80 years. The model of reality emerging today presents a fundamentally different picture than did the old classical notions of discrete, locally connected particles arranged in absolute space and moving through absolute time. Particle is being replaced by process, causality by synchronicity, and discreteness by undivided wholeness. We in psychology cannot afford to ignore these fundamental changes in assumptions as we attempt to plumb the depths of human consciousness.

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